Appendix R

History of River Work and Maintenance

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(Thirty-two strip maps, showing facilities and maintenance, are included in the electronic version of LCR MSCP Volume IV: *Appendices to Volumes I–III and V*.)

R.1 Introduction and Past History

Prior to construction of flood control and storage dams on the lower Colorado River (LCR), the lower river from the present site of Hoover Dam to Baja California was typical of a river carrying a heavy sediment load over an alluvial bed. Before the dams, the river was actively building up the alluvial valleys by repeated inundation when the spring snowmelt from the Upper Basin occurred. Each annual flood caused the river to meander across the alluvial valleys, cutting and depositing material in classical river meander patterns. During the ebb of the flood the river typically deposited a remainder of its sediment load on the valley floor.

The dams impounded the heavy load of sediment the river historically carried down from the Upper Basin, and significantly reduced the flood flows that carried most of the sediment through the system. The clear water released from the dams entered the channel practically free of sediment and immediately began acquiring a new sediment load. The dams caused the residual coarse sediment in the river to be redistributed with the result that farther downstream, below each dam, the quantity of sediment was sufficient that the river continued the natural process of meanders and aggradation.

Although river maintenance work started near Yuma, Arizona, prior to 1925, Congress did not pass the Colorado River Front Work and Levee System Act until March 3, 1925. The present authority under which Reclamation operates the Colorado River Front Work and Levee System is the act of June 28, 1946. This act authorized appropriations for controlling the floods, improving navigation, maintaining the banks of the Colorado River, dredging and straightening the river channel, and conducting studies necessary to fulfill the foregoing objectives.

The physical control and training of the LCR have generally been accomplished by the construction of the system of levees, river realignment, and river control structures. River control structures include bank line reinforcement, riprap, jetties, and training structures. Dredging activities have been used for channel realignment, development of material for levee construction, sediment control, and environmental enhancement.

Reclamation's Yuma Area Office (YAO) is responsible for maintenance of the Colorado River from the southerly international boundary (SIB) to Davis Dam, which is approximately 276 river miles. Each year YAO performs an inspection of the Colorado River and identifies bankline areas, levees, and river structures that require maintenance (Table R-1). For this ongoing maintenance activity on the river and levees, YAO has an annual need of 60,000 cubic yards or more of riprap and 20,000 cubic yards or more of gravel per year. See chapter two for bank and levee maintenance needs. Normally Reclamation crews perform the maintenance by hauling and placing the riprap on the banklines and levees. Reclamation endeavors to locate the quarry sites within economical haul distances from the stockpile sites.

Table R-1. Miles of Levee and Bank Line per Maintenance Division (south to north) of the Lower Colorado River

	Levee	Bank Line
1. Limitrophe Division RM 00 to RM 22.1		
A. Limitrophe Levee	22.1	
B. Limitrophe Bank Line		4.0
2. Yuma Division RM 22.1 to RM 43.2		
A. South Gila Levee	3.7	
B. Upper Yuma Valley Levee Arizona	7.9	
C. California Upper Reservation	11.4	
D. California Lower Reservation	4.2	
E. California Bank Line		6.5
3. Laguna Division RM 43.2 to RM 49.2		
A. Arizona Bank Line		4.73
B. California Bank Line		4.73
4. Cibola Division RM 87.3 to RM 106.5		
A. Arizona Levee	14.4	
B. Arizona Bank Line		16.25
C. California Levee	14.8	
D. California Bank Line		18
5. Palo Verde Division RM 106.5 to RM 133.8		
A. Arizona Bank Line		22
B. California Bank Line		22
C. California Levee	2	
6. Parker Division RM 1 33.8 to RM 177.9		
A. Arizona Bank Line		12.2
B. California Bank Line		12.95

	Levee	Bank Line
7. Mohave Division RM 233.9 to RM 276		
A. Arizona Mohave Levee	25.4	
B. Arizona Bank Line		20.6
C. California Bank Line		13.75
D. Mohave Levee Nevada	7.9	
E. Mohave Bank Line Nevada		9.75
Total	**113.8**	**167.46**

RM = river mile.

With the exception of bankline work in the Yuma and Limitrophe Divisions, most needed levees and banklines along the LCR are in place, and future work will not require the construction of new structures. Future work will only include periodic structure repair and stockpile replenishment as required to compensate for material that has been used for routine maintenance requirements and to repair flood damage. The annual amount of material needed may vary. The anticipated annual average need is 80,000 cubic yards of gravel and rock originally removed from quarries along the river.

Material used for routine maintenance activities and to repair flood damaged structures can be obtained from approximately 45 existing material stockpile sites. These sites are located along the lower river from near Davis Darn to the SIB. Material from any of these stockpiles may be used to repair flood damaged structures. The anticipated 80,000 cubic yards of material needed to annually replenish these stockpiles may be obtained from any of the existing quarries.

The first dredging on the Colorado River system occurred in the Yuma area in the early 1900s, and during the following 40 years incidental channel improvements were effected to correct local problem areas. Dredging is by definition the excavation of material under water, and the first machines were essentially of the dragline or bucket type.

The Bureau of Reclamation acquired the 16" hydraulic suction dredge "Colorado" in 1949. Work began in the Mohave Valley area to alleviate the flooding problem at Needles and was extended upstream to stabilize the meandering channel alignment. Subsequently, the dredge "Colorado" was moved to the Blythe area in the southern Palo Verde valley where it accomplished the channel realignment known as the Cibola Cut. The "Colorado" was then dismantled and replaced with 12" hydraulic suction dredges which are better sized for the scope and nature of the maintenance dredging and the remaining improvement projects. The present and foreseeable dredging program is described later in the sections pertinent to specific river maintenance divisions.

The Colorado River system has approximately 50 backwaters that would benefit from dredging and other physical renovation. The Back Water Subcommittee of the Lower Colorado River Coordinating Committee is presently prioritizing a list. Reclamation is prepared to provide dredging to those backwaters on a cost-shared basis.

R.2 Major Activities Along the Lower Colorado River

For administrative purposes the LCR has been divided into maintenance divisions that are roughly determined by different physical characteristics. The following discussions are indexed according to those divisions. The location of most of the river maintenance features is shown on the 32 strip drawings that follow this text. The drawings should be referenced when reading this appendix and corresponding river operation and maintenance sections of chapter two of the biological assessment.

R.2.1 Mohave Valley Division

The Mohave Valley Division is located between Davis Dam and the Topock Gorge. It is the northernmost of the ten divisions organized under the Colorado River Management Program. It includes the Cities of Laughlin, Nevada, Bullhead City, Arizona, and Needles, California.

Hoover Dam significantly reduced the annual floods that purged the LCR, however, flows were still large enough for scour and developed sediment to remain significant. Subsequent deposition of the sediment in the headwater delta area of Lake Havasu above Parker Dam, created a problem of severe aggradation in the lower Mohave Valley. At Topock, deterioration of the channel induced more deposition, and by 1943, sandbars extended across the entire channel causing water levels upstream to rise and cause serious flooding at Needles. Although emergency protective works were undertaken, channelizing the river was the only permanent solution. Channel stabilization was initiated in 1949 with the dredging of an improved channel between Needles and Topock and the river was diverted into the new channel on June 25, 1951. To prevent the same aggradation process from repeating itself, the Topock Desilting Basin was constructed in order to reduce the flow of sediment into Topock Gorge. This work and associated levee construction eliminated the immediate flood threat to Needles. However, it did not, by itself, provide the river stability between Davis Dam and Topock, which was needed to assure that the problem would not recur.

Channel dredging, levee construction, and associated bankline stabilization work, which reduced the pickup and transport of sediment, were subsequently accomplished upstream from Needles to a point 10 miles below Davis Dam. The continuous dredging in the Topock Desilting Basin was suspended in 1982 due to the gradual reduction of the sediment loads being scoured from the river as the bottom material coarsened and the river approached a steady regime level. Reclamation continues to monitor the sediment transport and river conditions. Dredging has continued in the basin since 1982 on an intermittent basis, and it is likely that maintenance dredging will be needed in the future.

Related work for the improvement of fish and wildlife habitats and recreational features has also been provided. Topock Marsh, which owes its existence to the completion of Parker Dam and the subsequent filling of Lake Havasu in 1938, has been encompassed with a dike to maintain water levels at an elevation of 455 feet mean sea level (msl). At this level, approximately 4,000 acres of open water are available for fisheries and wildlife

management. Inlet and outlet structures were constructed by Reclamation to control water apportioned to the Havasu National Wildlife Refuge. The high flows of 1983 and 1984 flooded parts of the Mohave Valley above Topock Marsh. As a result, a new flood control structure, Topock South Levee, was constructed in order to prevent mainstem floodwater from backing into Topock Marsh. At the same time, revegetation, water control structures, and aquatic habitat development were designed to enhance fish and wildlife conditions. Reclamation also participated in the development of the Needles Marina and Park Moabi near Topock. Beal Slough, a 30 acre backwater in the latter stages of succession, was dredged by Reclamation in 1979 and 1980 as a part of a cooperative study project aimed at fish and wildlife benefits.

R.2.2 Topock Gorge Division

The Topock Gorge Division extends from the upper end of Topock Gorge to the upper end of Lake Havasu. Minimal maintenance work has been conducted in this Division in the past, due to the natural channel configuration and substrate, which consists of a deep channel bounded by high canyon walls. These are broken to form various small backwater wetlands. This division is entirely within the Havasu National Wildlife Refuge.

R.2.3 Havasu Division (including Parker Strip)

The Havasu Division includes all of Lake Havasu and the river between Parker and Headgate Rock Dams. The effects of the high flows on the river are marked in this division by sediment deposition in the upper end of Lake Havasu. The high flows of 1983 and 1984 deposited 10 million cubic yards of river sediment and extended the existing delta.

The water level in Lake Havasu fluctuates between 440 to 450 feet msl in accordance with the Parker Dam operating criteria, although for practical purposes, the lake elevation has been maintained above 445 feet msl for the last 15 years. During a flood, a potential surcharge to elevation 455 feet msl may develop.

In the Parker Dam to Headgate Rock Dam reach, an area commonly known as the Parker Strip, water levels are determined by discharge from Parker Dam and the backwater effect from Headgate Rock Dam. General channel stabilization activities are minimal due to the channel and bankline substrate. Most stabilization activities in this reach are conducted by entities other than Reclamation to protect local facilities.

This division is the most intensely developed area for recreation along the river. The Parker Strip has been heavily developed for recreation purposes, and in recent years thousands of people have visited Lake Havasu to boat and water ski. Flood releases of 40,000 cubic feet per second (cfs) from Parker Dam in 1983 caused damage to homes and businesses with river frontage in the Parker Strip. Currently, releases in excess of 20,000 cfs begin to effect damage to improvements along the banks of the Parker Strip.

R.2.4 Parker Division

The Parker Division is located between Headgate Rock and Palo Verde Diversion Dams, and encompasses most of the lands of the CRIT' Reservation. It is divided into two sections, Parker I & II, for better administration of the division. Parker I begins at Headgate Rock Dam and ends 2 miles south of Agnes-Wilson Bridge. Parker II starts at river mile (RM) 163.3 and extends to RM 133.8, at Palo Verde Diversion Dam.

The channel improvement work in Parker I was completed by 1967. The major aspects of the Parker II channel improvement and stabilization work was completed in early 1995. During the next few years, as the river adjusts to the channel improvements, minor corrective work may be required.

No Name Lake is a backwater area located in the Parker II Division. Approximately 1,200,000 cubic yards of material are to be excavated and placed in the designated areas to restore the Lake to pre-1983 conditions. This is a portion of the mitigation for the Parker II Channel Modification Project.

Other potential marsh and aquatic enhancement in this division includes the rehabilitation of the Deer Island complex and a large lake and marsh in the Parker I area.

R.2.5 Palo Verde Division

The division begins at the Palo Verde Diversion Dam and extends to Taylor Ferry near the Imperial County, California line. Channel stabilization and other improvements are essentially complete in the Palo Verde Division and work primarily consists of routine maintenance and repair to structures. Previous work in this area consisted of earth fill training structures and bank protective riprap designed to prevent random meandering.

Reclamation maintains 5 mitigation backwaters in this Division. The frequency of maintenance is determined by events that may cause the backwaters to fill in due to sediment, or other factors.

R.2.6 Cibola Division

The Cibola Division extends 19 miles from the lower end of the Palo Verde Division to Adobe Ruin, near Walter's Camp. Through much of the Cibola Division, the natural channel was shallow due to sediment deposition. A program to correct channel deficiencies by dredging and constructing levees was initiated in 1964 and completed in 1970. The old river channel was essentially abandoned and became a part of the Palo Verde outfall drain. The river channel in this division is totally stabilized through the use of dredging, bankline riprap, training structures and jetties.

Three Finger Lake is a decadent wetland located on the old river channel and within the Cibola National Wildlife Refuge south of Blythe, California. Approximately 800,000 cubic yards of material have been excavated and placed adjacent to the design

lake configuration to restore the lake to its historic conditions. This is a cost-shared effort with the U.S. Fish and Wildlife Service.

R.2.7 Imperial Division

The waters behind Imperial Dam, including associated backwater areas constitute the Imperial Division. The division extends through the reach from the lower Cibola Valley, to Imperial Dam. This division receives the sediment generated in the Parker, Palo Verde, and Cibola Divisions. The sediment load arriving in the Imperial Division is either deposited in the overflow areas outside of the main channel or eventually arrives at Imperial Dam to be removed in the desilting works and the reservoir located directly upstream of the dam.

In planning for the Parker, Palo Verde, and Cibola Divisions, reducing the sediment flowing into the Imperial Division was a major objective. Reclamation continually collects and processes data on sediment transported by the river. This allows needs to be defined, appropriate corrective measures to be instituted, and the results of control measures to be adequately evaluated.

Most of the diverted sediment is removed by the Desilting Works for the All-American Canal, returned to the river below Imperial Dam and dredged to permanent dry land storage areas near the Laguna Desilting Basin, located about 1 mile above Laguna Dam. The desilting works for the Gila Gravity Canal are maintained periodically, by sluicing sediment accumulations down to the Laguna Desilting Basin for removal by dredging.

Dredging above Imperial Dam is conducted periodically to maintain diversions for water demand into the All-American Canal on the west end of the dam and the Gila Gravity Main Canal on the east end. At an interval as short as 3 to 5 years, between 800,000 and 1,500,000 cubic yards of sediment are removed from the reservoir basin up stream of Imperial Dam. It takes approximately 6 months to 1 year to remove sediment from this area. Dredging is performed upstream of the All-American Canal headworks, the California sluice gates, the overflow weir, the gravity main canal headgates, and the Arizona and California channels just upstream of the dam face. Sediment is dredge-pumped into the river channel below the dam for transportation to the Laguna Desilting Basin.

R.2.8 Laguna Division

The Laguna Division includes the area between Imperial and Laguna Dams. The Laguna Division receives the sediment returned from the All-American Canal Desilting Works and removed from the reservoir upstream of Imperial Dam and Laguna Dam. Because this sediment traveled downstream and created problems associated with 1944 Water Treaty diversions at Morelos Diversion Dam, in the mid 1960s, Reclamation constructed a desilting basin in the Laguna Division where sediment from upstream sources is trapped and pumped with a dredge for disposal onto adjacent dry land.

The time span between dredging depends on the sediment load. Under the present forecasts it appears the work may be scheduled at 5-year intervals. The desilting basin is approximately 4,000 feet long by 500 feet wide and is normally excavated to a depth of about 25 feet. The total capacity is approximately 2 million cubic yards. Working a two-shift schedule it takes approximately 12 months to excavate the basin when it is half full. It is necessary to keep the basin at about half capacity or less, since the trap efficiency (ability to capture sediment) drops off dramatically as it passes the half-way point. It is noted that the basin is to be extended to 5,000 feet in fiscal year (FY) 2004.

Included within this division is Mittry Lake, a shallow lake east of the Colorado River channel and north of Laguna Dam. The lake has a surface area of approximately 750 acres and is fed by an in let structure originating at the head works of the Gila Gravity Main Canal.

R.2.9 Yuma Division

The Yuma Division is the reach of the river located between Laguna Dam and Morelos Diversion Dam. The river channel extending from Laguna Dam to the upper end of the diversion pool above Morelos Diversion Dam was formed by the undiminished natural flow of the river before the dams were constructed. This dominant flow, the flood flows most affecting the channel shape, averaged about 20,000 cfs with maximum flows in the early 1900s exceeding 200,000 cfs, depending upon the time of year and location within the division. While the historic riverbed averages 600 feet in width, only about 120 feet is presently occupied by river flows. The remaining portions of the riverbed, at or near the elevation of ground water, support various growths of vegetation: cattails, cane, arrowweed, saltcedar, mesquite, cottonwood, etc. In the past, vegetation affecting flow and access was partially controlled by intermittent programs of mechanical vegetative control: mowing or cultivating. Presently, there are no plans to continue this type of maintenance.

A 1969 plan for this division called for renovation of the low-flow channel by dredging, reshaping, and lowering the water table under the remainder of the riverbed, and instituting a program of vegetative control. After completing most of the work in the upper 6 of the 20 miles of river channel in the division, the work was suspended pending resolution of environmental concerns. These concerns were met by dredging the area that is currently the open water in Mittry Lake. Prior to that, little open water existed. The lake is now heavily used for fishing.

During the high flows of 1983-1984 the channelization work was destroyed, and the river attacked the levees in several places, which resulted in emergency maintenance. The whole floodplain was essentially inundated, and farm drainage was severely affected.

The 1993 Gila River flood deposited 10 million cubic yards of sediment in the Colorado River channel from the confluence of the Gila River to Morelos Diversion Dam and raised the river bottom an average of about 5 feet. This has resulted in complaints from local farmers that the elevated river bottom resulted in groundwater problems under their cultivated lands. Mexico has also complained that the sediment deposition was making their diversion of 1944 Water Treaty water at Morelos Diversion Dam more difficult.

Due to the flooding of the Gila River in 1993 and high water releases from Painted Rock Darn in 1995, dredging was performed under separate Endangered Species Act compliance from Morelos Diversion Dam to the northerly international boundary (NIB) in 1995. The Morelos Diversion Dam to Cocopah Bend reach was dredged in 2000. In all a total of two million cubic yards of sediment was removed, still leaving about 8 million cubic yards in the river channel immediately up stream. The sediment that was removed increased the capacity of the river channel to help prevent overtopping the levees during large floods and to lower the water table in the Yuma Valley.

Dredging of the river channel between the NIB and Cocopah Bend is expected to occur every 5 to 10 years. The purpose of the dredging is to maintain a flow capacity in the river channel of 15,000 to 20,000 cfs.

R.2.10 Limitrophe Division

The Limitrophe Division extends from Morelos Diversion Dam near Yuma, Arizona, to the SIB near San Luis, Arizona. The river channel in this division is essentially dry during normal water years, due to the diversion of 1944 Water Treaty water for Mexico at Morelos Diversion Dam. Also, considerable sediment was deposited in this reach of the river during the 1993 Gila River flooding. The United States and Mexican Sections of the International Boundary & Water Commission (IBWC) are currently working on plans to reestablish the international boundary, a low-flow river channel, and a floodway capacity capable of handling flood flows similar to those that occurred during the 1983–1985 period, and again in 1993. Severe property damage occurred to Mexico during those events. This international work will have its own Federal Endangered Species Act (ESA) compliance separate from the LCR MSCP coverage.